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Assessment of the Effect of On-Farm Management Strategies on Milk Yield and Milk Composition of Small and Medium-Scale Dairy Farms in Addis Ababa, Ethiopia

MSc Thesis for the Partial Fulfillment of Master of Science in Animal Production Technology

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Assessment of the Effect of On-Farm Management Strategies on Milk Yield and Milk Composition of Small and Medium-Scale Dairy Farms in Addis Ababa, Ethiopia

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LIST OF ABBREVIATIONS

ADMY	Average Daily Milk Yield
AI	Artificial Insemination
CES	Compulsory Ethiopian Standards
CSA	Central Statistics Agency
DMY	Daily Milk Yield
F	Fat
FUADC	Farmers and Urban Agriculture Development Commission
GDP	Grosse Domestic Product
HF	Holstein Frisian
L	Lactose
MS	Medium Scale
NBE	National Bank of Ethiopia
NM	Natural Mating
P	Protein Percentage
SNF	Solid Not Fat
SS	Small Scale
TS	Total Solid
W	Water Content
WB	World Bank

ABSTRACT

The study analyzed the impact of farm management strategies on milk yield and composition in small and medium-scale dairy farms in Addis Ababa, Ethiopia. The study involved 182 farms, with 107 medium and 75 small-scale farms categorized based on cattle size (>5≤30 dairy cows) and (≤5 dairy cows), respectively. Dairy owners were interviewed, and 30 milk samples were analyzed for chemical composition using a lactoscan milk analyzer. The study used Statistical Package for the Social Sciences SPSS, version 20 for data analysis, comparing milk yield and composition of dairy cows. Descriptive statistics and independent T-tests were used, with qualitative data interpretation to complement the quantitative findings. Both medium and small-scale dairy farms utilize conventional housing but require enhancements in design, maintenance, breeding management, record-keeping, waste management, and animal health practices. Medium and small scale farms exhibited similar mean daily milk yields of MS 13.93 ±3.16 liters and SS 14.63 ± 3.09 liters. The t-test value for the difference in daily milk yield between the two farm scales is 1.475, with a corresponding p-value of 0.142, which is higher than the significance level of 0.05 and lactation lengths of medium scale 8.05 ± 1.23 months and small scale 8.1 ± 1.24 months. The t-test value for the difference in lactation length between the two farms is 0.616, with a p-value of 0.796; it shows that there are no statistically significant differences between the two farm scales in terms of lactation length and daily milk yield. The daily milk yield was found to be shorter than in previous studies. While small scale farms demonstrated higher fat content of (4.43% ± 1.408%) higher than (2.53% ± 1.54%), medium scale was also lower than 3.34 compulsory Ethiopian standard (2021) statistically significant at t = 3.411 and p-value 0.002, and total solids of (12.87% ± 1.568%) in milk compared to medium scale farms of 10.85% ± 1.533%, which is statistically significant at t = 3.497 and statistically significant (p-value = 0.002), the differences in other quality parameters were not statistically significant. The study suggests that factors like blood level, nutrition, and management practices may significantly influence milk composition in farms, regardless of their scale. Government and none governmental organization support is crucial for sustainable dairy cattle management training, improving feed formulation, herd health, breeding management, and entrepreneurial skills. Prioritizing waste management and milk composition testing can enhance production productivity and product quality.

Key words: - milk yield, milk composition, management practice, medium and small scale.

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1. INTRODUCTION

1.1 BACKGROUND

Ethiopia is the second most populous country in Africa, with an estimated population of 126.5 million as of 2023 (World Bank 2024).The country's economy is heavily reliant on agriculture, which accounts for 37.64% of its gross domestic product (GDP) according to (O'Neill, 2024). Ethiopia is known for having the largest livestock population in Africa, with an estimation of 70 million cattle (CSA, 2021). Among these female cattle make up around 56% of the total cattle population, while males account for the remaining 44%. Despite its large cattle population, Ethiopia's milk production is relatively low, standing at 4.96 billion liters per year with an average milk yield of just 4.96 liters per cow per day (CSA, 2021). This is significantly less than the World Health Organization's recommended consumption of 200 liters per person per year. Milk production in Africa as a whole has remained stable, with 49 million tons produced, but some countries, including South Africa, Kenya, and Ethiopia, have experienced decreases(FAO, 2020).

The majority of milk produced in Ethiopia comes from small-scale dairy farms, which provide a vital source of income and food for 300 million farming families worldwide as (Didanna *et al*., 2018). Ethiopian farmers have traditionally used crossbred cattle, combining local zebu and imported Holstein-Friesian breeds, to boost milk production. However, the performance of these crossbred cows is influenced by various factors, and continuous analysis is required to evaluate the effectiveness of dairy production and crossbreeding initiatives (Taye et al., 2023). While there are a few small-scale and medium scale commercial dairy producers in Ethiopia, the majority of the country's dairy products come from subsistence farmers. The demand for milk and milk products is growing, driven by population growth, urbanization, and improvements in living standards as (Hatew *et al*., 2023) .

Addressing the low productivity and output of the dairy industry will be crucial to meet the increasing demand and improve the nutritional status of the Ethiopian population. Poor feed quality and availability, seasonal variations, and reliance on crop residues and natural grazing areas are obstacles to Ethiopia's dairy development ((Mihret et al., 2017). Other obstacles to Ethiopia's dairy industry are disease and poor animal health. Many

endemic diseases are common and can have a major effect on milk output and quality, including brucellosis, foot-and-mouth disease, and mastitis ((Duguma et al., 2012). According to Amare *et al*., (2019) farm categorized in to three parts based on cattle size, small-scale farms often consist of five or fewer dairy cattle; large-scale farms have more than thirty dairy cattle and medium scale farms with between five and thirty dairy cattle. Ethiopia's government has developed a plan to boost the expansion of dairy output in order to fulfill the region's increasing demand for milk and milk products. As a result, there are now more dairy farmers in cities and suburbs than ever before. These farmers are crucial to the expansion of the dairy business as a source of food for families, income, and employment opportunities (Duguma, 2022).

Dairy farming involves managing cows for milk production, which is crucial for global demand. Understanding dairy farm operations and challenges is essential for considering the details of milk production (Krznaric, 2023).

In both urban and peri-urban areas, the production of fluid milk is the main focus for farmers. They often face limited or no access to pasture land, feed, or fodder. Employees in this production system typically have better access to inputs, veterinary care, and more commercial management practices. This system is responsible for about half of the premium breeds and crossbreds (Sander *et al*., 2021). According to Ethiopian Agricultural Transformation Agency (ATA), (2022) report by the dairy production in Addis Ababa has seen significant growth in recent years and is the largest producer of milk in Ethiopia, accounting for about 20% of the country's total milk production. However, it still faces several challenges (ATA, 2022).

Various factors such as breed, diet, health, and weather affect the quantity and composition of milk produced. The amount and duration of lactation, among other physiological characteristics, also influence the yield and composition of milk in dairy cows. Bekele *et al.*, (2023) highlight that understanding the milk yield and composition performance of crossbred dairy cows in different production scenarios can aid in selecting a more productive genotype.

Milk is a complex mixture of water (W), fat (F), protein (P), lactose (L), enzymes, minerals, organic acids, and vitamins (Duguma, 2022). In Addis Ababa, many dairy farms are operated by individual families or small cooperatives. These farms may lack

access to advanced milk testing facilities and expertise compared to larger commercial dairies. Having consistent, affordable, and accessible milk composition analysis is crucial for these smaller producers to:

- Ensure their milk meets quality standards for sale to processors or consumers

- Optimize feeding and herd management practices to improve productivity

- Detect any adulteration or contamination issues early

- Access premium pricing for high-quality milk

Reliable milk testing can help these farms improve their competitiveness and profitability. Therefore, a study is needed to examine how on-farm management techniques influence the yield and composition of milk in small- and medium-sized dairy farms in Addis Ababa. This study aims to bridge the existing knowledge gap and provide data-supported insights to enhance the productivity and profitability of dairy farming.

1.2. STATEMENT OF PROBLEM

The dairy sub-sector is crucial in generating household income and providing a food source. There is an increasing demand for milk and milk products due to urbanization, rising incomes, and population growth. However, many dairy farms in the region experience suboptimal milk yield and composition due to ineffective on-farm management strategies. This study explores potential differences in the effects of on-farm management strategies between small-scale (SS) and medium-scale (MS) dairy farms. It is important to conduct a detailed analysis of individual strategies such as feeding management, housing management, herd health management, breeding, and waste handling management, as these factors can significantly impact the quantity and quality of milk produced.

Applying appropriate technological, scientific and sustainable approaches to dairy farming is one of the limited factors. Addressing this knowledge gap is crucial to helping dairy farmers in Addis Ababa optimize their operations and enhance the overall performance of the dairy sector. The findings from this study could guide the development of targeted extension services, training programs, and policy interventions to support dairy farmers in adopting best managerial practices and improving milk yield on their farms.

1.3. OBJECTIVES

1.3.1. General Objective

To assess the effect of on-farm management strategies on milk yield and composition in small- and medium-scale dairy farms in Addis Ababa, Ethiopia.

1.3.2. Specific Objective

- To evaluate the current on-farm management practice implemented in small- and medium-scale dairy farms in Addis Ababa.
- To determine the impact of different on-farm management strategies on milk yield and composition in small- and medium-scale dairy farms in Addis Ababa.
- To identify challenges and opportunities in small- and medium-scale dairy farms in Addis Ababa.

1.4. RESEARCH QUESTIONS

1. What are the different on-farm management strategies employed by SS and MS dairy farms in Addis Ababa?

2. How do different on-farm management strategies affect milk yield and milk composition?

3. What are the main challenges faced by dairy farmers in adopting effective on-farm management practices?

What recommendations can be made to improve milk yield and composition through better on-farm management?

1.5. SIGNIFICANCE OF THE STUDY

This study is providing valuable insights in the impact of on-farm management strategies on milk production in SS and MS dairy farms in Addis Ababa. The findings can be used to develop tailored recommendations for improving dairy farm management practices, potentially leading to increased milk yield and improved milk composition. The study may contribute to the overall understanding of dairy farming practices in Ethiopia, which could inform policy decisions and agricultural development initiatives.

1.6. SCOPE AND LIMITATIONS OF THE STUDY

The study focuses on small and medium-sized dairy farms in Addis Ababa, Ethiopia. It covers various aspects of on-farm management practices, including feeding, housing, herd health, and breeding strategies, and their impact on milk yield and composition. However, the study has some limitations. The findings may not be generalizable to large-scale dairy farms or other regions with different climatic and socio-economic conditions. Additionally, the study relies on self-reported data from farmers, which may introduce biases or inaccuracies.

2. LITERATURE REVIEW

2.1 OVERVIEW OF DAIRY FARMING IN ETHIOPIA

Ethiopia's annual per capita milk consumption between 2003 and 2012 ranged from 32.8 to 36.5 liters as reported Yilma *et al.*, (2017).. According to CSA (2023), amount of milk produced annually increased from 3.2 billion liters in 2015 to 4.5 billion liters in 2022. Gebreselassie, (2019) identified several factors affecting Ethiopian dairy cattle's milk production capacity , including inadequate high quality and quantity feed, high feed cost,, diseases, land scarcity for the production of improved forage production, lack of improved breeds, insufficient milk processing milk facilities; poor animal management; adulteration; improper waste disposal and market oriented production deficits.

Table1, Cattle population, proportion of female herd, dairy cows, and annual milk production in Ethiopia

Year	Cattle population (million)			Female + (%)	Number of dairy cows (million)	Dairy cows out of female population (%)	Annual milk yield (billion liters)
	Total	Female	Male				
2014/15	56.71	31.44	25.26	55.45	6.50	20.66	3.07
2015/16	57.83	32.02	25.81	55.38	6.74	21.05	3.06
2016/17	59.49	33.01	26.48	55.49	7.16	21.68	3.10
2017/18	60.39	33.02	27.37	54.68	6.66	20.17	3.10
2018/19	61.51	34.24	27.27	55.67	7.09	20.71	3.30
Average	59.19	32.75	26.44	55.33	6.83	20.85	3.13

Source: CSA (2015-2019)

2.2 ON-FARM MANAGEMENT STRATEGIES

2.2.1. Feeding Management

Livestock feeds are the major inputs in any milk production activity as (Melku *et al.*,2016) cited. Effective feeding management is crucial for the productivity and profitability of urban dairy farms in Ethiopia according to a study by (W. Bekele *et al*., 2019). On the other hand Feed resources are classified as natural pasture, crop residue, improved pasture and forage, agro industrial by products and other by-products like food and vegetable refusal, of which the first two contribute the largest feed types as cited by (Ketema Worku,2014). Reliance on purchased feed: Urban dairy farmers often rely heavily on purchased concentrate feeds, such as wheat bran, oilseed cakes, and commercial dairy rations, to supplement the limited availability of on-farm feed resources (W. Bekele *et al*., 2019). Use of crop residues: such as tef (Eragrostis tef) straw, wheat straw and maize Stover, are commonly used as basal feeds on urban dairy farms as (Biratu,2022), Improving the quality and utilization of crop residues through appropriate treatment methods, such as urea treatment or physical processing (Mengistu *et al*.,2017). Grazing and cut-and-carry systems: Some urban dairy farmers practice limited grazing or cut-and-carry systems, using forages from public or communal lands, as well as cultivated fodder crops like Napier grass (Pennisetum purpureum) (Tegegne *et al*.,2016).

Effective feeding management on urban dairy farms in Ethiopia involves, Balancing the use of purchased concentrates and available on-farm feed resources to meet the nutritional requirements of the dairy cattle as (Melesse *et al*.,2023). Expanding the cultivation of improved forage species and integrating them into the feeding system (Tegegne et al.,2016). Improvements of feed storage and conservation techniques that ensure a consistent supply of feed throughout the year (Biratu,2022). Adopting precision feeding techniques, such as the use of ration formulation software, to optimize feed utilization and reduce feed costs (Melesse et al.,2023).

According to (Tolasa et al.,2020) the primary feed and feeding practices in the urban and peri-urban areas of Holetta, Bishoftu, Sululta, and Assela were stall feeding and restricted grazing. In the municipalities of Bishoftu and Akaki, the percentage of dairy owners that used stall feeding in combination with restricted grazing feeding methods was 75.6% and 25.4%, respectively. The main source of nutrition for dairy cattle in the towns of Jimma, Badalle, Ambo, Gimbi, and Naqamte was pasture, either by itself or in combination with

sporadic stall feeding as cited by (Alemu,2019). The feeding habits of native and crossbred cows vary greatly, stall feeding with a concentrate and grass mixture is the most popular method in the cities of Adet and Merawi, whereas seasonal grazing is the practice in Ejere and Hinchini as(Tolasa *et al*.,2020) cited. Crossbred cows produce more milk than native cows since they require a greater quality and quantity of feed. Hay, crop residue, grazing, crop after treatment, and innovative feeds like Atella a byproduct of the manufacture of local beer—were found to be the main feed sources in Adwa and Axum (G.Tesfay,2015). On the other hand, concentrates (such noug cake and wheat bran), agricultural waste, stored hay, certain forage legumes, and vegetable and fruit wastes were the main sources of feed in Bishoftu (Jalel *et al*.,2020). In Addis Ababa, the two most common feed types were hay and wheat bran (Alemu,2019). The main crops used as cow feed at the farm in Hawassa City were attela, grass hay, stover (especially maize stover), and industrial wastes (Mohanis,2015). At Shambo, Fincha, and Kombolcha, concentrate feed consisting of wheat bran, noug cake, and salt is given to cows and calves during the dry season (Tolasa *et al*.,2020). For their crops, most farmers in Jimma Town mostly use green feeds; the three most significant concentrate supplements are nug cake, commercial concentrate mix, and wheat bran (Duguma,2022).

2.2.2. Housing Management of Dairy Cow

Good housing conditions can improve milk production by reducing environmental stress (Broucek *et al*.,2017). Housing conditions have a big influence on dairy cattle welfare. Systems that have access to pastures, the outside world, or both include tie stalls, loose housing, and free stalls according to (FAO, 2019).

Global climate change presents issues for the dairy industry. Therefore, establishing reliable correlations between these parameters and the physiological responses of animals is the first step toward statistically simulating the future effects of environmental conditions on cows' well-being and milk production (Mylostyvyi and Chernenko,2019). It is commonly accepted that nursing animals are especially vulnerable to high temperatures and high humidity since these conditions have a significant impact on their health, growth, development, and ability to lactate (Zhu *et al*.,2020).

In South Wollo Zone, Dessie Town, Ethiopia, all urban and per-urban farmers (100%) maintained their dairy cattle in individual homes (Ayalew and Abatenhe,2018). Also,((A. Kiros *et al*.,2018) nearly 80% of urban and 3.33% of peri-urban medium- and large-scale

dairy farms in Holetta, Bishoftu, Sululta, and Assela employed separate housing systems. In the urban dairy production system of Boditti town, Wolaita Zone, 60% of dairy farmers kept their animals and their family in the same house (Feleke *et al.*,2016). The disparities could be brought about by issues with finance systems and differences in managerial practices. Just about half of farmers in West Gojam and West Shoa peri-urban areas house their cows in upgraded, separate housing; the remaining 40% and 80% of farmers in these areas provide feeding and drinking troughs in their barns, respectively, this contrast to the majority of farmers in urban areas (Gizaw *et al*.,2016). Most of the accommodation in the peri-urban dairy production system of Shambo and Kombolcha was covered; 65.6% of the cows lived in shade, while the remaining 34.4% slept in conventional barns or open backyards (Dugguma *et al.*,2015). In Bishoftu Town, permanent housing is provided for cattle on most farms; of the dairy farms, 83% of the housing is covered, while the remainder housing is not (Alemu,2019).

When the temperature increased from 6.2 °C to 31.3 °C, the milk protein, fat, and SNF all experienced significant drops, by approximately 4.09%, 5.75%, and 1.31%, respectively. When the humidity rose from 54% to 82%, the milk protein, fat, and SNF all considerably increased by around 3.61%, 4.84%, and 1.06%, respectively (Toghdory *et al*.,2022) .In aperfect environment, animals that are breastfed can develop healthily and produce milk. Conversely, adverse environmental conditions can affect the metabolism of the organism and cause decreases in the amount, makeup, and caliber of milk that nursing animals produce(Menéndez-buxadera *et al.,* 2021).Lower quality milk is produced when any of these components—solids-not-fat, dry matter, milk fat, and milk protein—increase or decrease. (Khastayeva et al.,2021). Milk fat and protein levels are two major factors that change significantly with the seasons (Bokharaeian *et al*.,2023), (Ramón *et al.*,2016). According to a (Toghdory *et al.*,2022), The milk content of dairy cows changed as a result of high temperatures.

2.2.3. Health and Disease Control Management

Disease is a major problem for the dairy reproductive or milk production system, and diseases that affect nursing animals—like mastitis, ketosis, hypo calcemia, and milk fever can seriously hurt dairy farmers' bottom lines(B. Alemu,2019) and According to (Alemu,2019), The most prevalent medical conditions that were noted were diarrhea (50.7%), respiratory problems (48.8%), and external parasite infestation (87.6%). The

majority of farms had tick infestations (76.1%), which were followed by mange mite infections (17.9%), lameness (61.2%), and different basic and/or complex wound concerns (23.9%). According to (B. Alemu,2019) showed that dairy cows kept under different management regimes in and around Kombolcha, Northern Ethiopia, had a variety of reproductive health problems, including dystocia, brucellosis, lameness, and sterility. As stated by (Arnould *et al.*,2013) Most metabolic issues in dairy cows appear in the first few weeks of lactation. It is true that the increased nutritional needs of the cow, resulting from an increase in the activity of her mammary glands, are not always met. Higher-yielding cows are more economically affected by three conditions: milk fever, ketosis (sometimes called acetonemia), and mastitis.

2.2.4. Breeding Management

While numerous dairy owners used bull service, AI was the primary breeding technique in the urban and peri-urban districts of Holetta, Bishoftu, Sululta, and Assela(Kiros *et al.*,2018). As (Feleke *et al.*, 2016) indicated that 35% of the households in Boditti town's mixed crop/livestock production system use AI, 65.4% of the families use natural mating (NM) with local bulls, and 1.7% use both natural mating and AI services. According to (Aseged *et al.*,2023)Showed that NM is the only way dairy farmers in the Metekel zone of northwest Ethiopia utilize to inseminate their cows. In the Borana zone, 84.2% of mid-highland and 75.2% of lowland regions, on average, used natural bull service for breeding(Takele Gebissa,2014). also, (Tolasa *et al.*,2020) In the towns of Bishoftu and Akaki, AI is utilized by 50.8% and 46.4% of farms, respectively, to produce dairy cattle. However, (Feleke *et al.*,2016) Showed that 51.7% of the households in the urban system of Boditti town used NM by local bulls, while 48.4% of the homes used AI. The differences may be influenced by the availability of breeding bulls, farmers' awareness, the ease of receiving selected services, the affordability and accessibility of AI services, and more. Nevertheless, a discovery made by(Bogale *et al.*,2021) Showed that 48.4% of the residences in the Boditti urban system The bulk of dairy farmers in the East Wollega zone (50.5%) bred their cattle using both AI and NM, according to research from Ethiopia.

In Addis Ababa, the AI method accounts for 77.4% of the mating system due to its accessibility, while NM is used by 3% of the population and AI by 19.4% of the population.(Alemu, 2019) Only fifty percent of Shashemene and Dilla's population combines AI with NM, while the other fifty percent employs AI entirely for genetic growth.(Sabaruddin,, 2016). Gondar, in comparison, has a hybrid mating rate of 22.5%,

20% AI and 57% NM (Chanie *et al.*,2018). In cases when the cost and availability of AI are decisive concerns, 51.7% of Boditi's matings involved local bulls were Nm, while 48.4% involved the use of AI(Feleke *et al.*,2016). In Bishoftu, AI is used by just 22.5%, NM is used by 40% of the population, and both are used by 37.5%. (Alemu, 2019). It all depends on accessibility when cows are in estrus. But in contrast, as stated by (Zemenu *et al.*,2017)Dairy cattle were exclusively bred naturally in and around the town of Debre Markos, Farmers' access to and inclination toward conception insurance account for the disparity in AI adoption against bull.

2.2.5. Dairy Farm Recording

Accurate record-keeping is necessary for efficient dairy management. Because there are no written records, farmers are compelled to base their decisions about their farming operations solely on their recollection. But after a few days, weeks, or even years, memories might fade (SNV, 2017) .As stated in the report of (Kiros *et al.*, 2018)Many dairy producers did not keep their records up to date. Similarly, the main excuse offered for the lack of record-keeping by 95% of dairy producers in and around Boditti town, South Ethiopia, was their misunderstanding of the benefits of doing so(Feleke *et al.*, 2016). A lack of documentation can impede development, have a detrimental impact on output, and lead to inbreeding amongst closely related herds(Kiros *et al.*, 2018). The three main variables that dairy farmers monitored were calving dates, service, and milk yield(Kiros *et al.*,2018). Similarly, (Feleke *et al*.2016)added that it was discovered that 27.8% of farmers in the vicinity and 42.7% of dairy farmers in and around Wolaita Sodo town kept reproduction and breeding/AI records, respectively.

2.3 DAIRY PRODUCTION

2.3.1 Milk Yield

According to (Melku et al.), all small-holder in the urban areas and the mixed small scale dairy production systems are labor oriented, where milking is done by hand, and often done twice a day. Production on most smallholder farms relies heavily on family labor. Crossbred cows in the towns of Bishoftu and Akaki were estimated to have daily milk yields (DMY) of 11.6 and 10.8 liters, respectively(Kiros *et al.*,2018).The milk shed in Adama states that 11.3 liters(Jalel *et al.*,2020).Crossbred cows in Hawassa have an average daily milk yield (ADMY) of 10.32 liters. (Alemu, 2019); (Z *et al.*,2017), who recorded 7.3 liters in the town of Debre Markos, and (Melku et al.,2016), who measured

7.8 liters at the Gondar and BahirDar peri-urban milk sheds. (Tasew and Eyassu, 2009), conversely, 5.2 liters of DMY were detected by Bahir Dar Zuria. As mentioned by(Alemu, 2019), The three towns that make up the Horo Guduru Wollega zone produced 7.21 liters of milk daily on average. These showed a relationship between the measured daily milk yield and the size of the city housing dairy operations. Larger cities may have more access to marketplaces, veterinary care, AI, concentrate feeds, and other inputs.

Table 2 : Dairy producers, dairy animals, and milk production by sub-city - June 2023

NO	Sub-city	Number of dairy producers	Number of dairy animals	Number of milking cows	Average milk yield/day/cow L
1	Yeka	565	4533	2720	18
2	Bole	692	1276	766	15
3	Kality	968	4000	2400	18
4	N/Silk	729	2130	1278	15
5	Kolfe	1268	3820	1292	15
6	Gulele	314	942	565	15
7	Kirkos	90	400	240	12
8	Arada	45	100	60	13
9	Lideta	145	839	503	15
10	Addis Ketema	80	246	148	10
11	Lemikura	163	733	440	15
	Grand Total	5,059	19,019	10,411	Ave =14.64

Sources (FUADC, 2023)

2.3.2 Lactation Length

The lactation duration is the amount of time a cow secretes milk after giving birth until it dries off. It is advised to nurse for 10 months in order to benefit from the two-month dry period. As stated by(Taye *et al.*, 2023), Crossbred dairy cows in Debre-Birhan and Sebeta typically lactated for 9.7 and 10 months, respectively. Similarly, lactation durations of 10.53 and 12.0 months have been reported for the Oromia region's cities of Shambu and

Kombolcha, respectively(Alemu, 2019). At 10.8 and 11.4 months in Melkasa and Welenchiti, respectively(Dinkissa and Guye, 2022). According to (Dinkissa and Girgo,2022), The results are 8.7 months in Debre Markos and more than 9.17 months in Gondar town(Alemu, 2019). In Bahir Dar Zuria, however, (Getachew and Tadele, 2015)discovered that eleven months were spent lactating. As mentioned by (Genzebu *et al.*,2016), In Bishoftu, lactation lasted 9.22 months, while in Akaki towns, it lasted 9.36 months. The ten-month lactation period of the animal was noted during (Alemu, 2019). In the North Shoa zone, native dairy cows breastfed for 9.13 months, while crossbreds breastfed for 11.13 months(Hatew *et al.*, 2023).

2.4 MILK COMPOSITION

2.4.1. Chemical Composition of Milk

Different species' milks have similar components overall, despite minor differences in content and characteristics. The average milk protein percentage for genetic groups with less than 50% variation is less than the 3.8% stated by(Kebede, 2018)for dairy cows that are 50% hybrids. The fat percentage was highest for the genetic group with < 50%, but it decreased as the fraction of foreign genes grow(Ceruiyot *et al.*,2018).

Milk contains 12.6% milk solids (consisting of 3.7% “F” and 8.9% milk SNF) and 87.4% W on average. Minerals (0.7%), L (4.8%), and protein (3.4%) are present in the fat-free milk solids (Samuel Abose, 2020). A minimum of 8.5 percent “SNF” and 3.5 percent milk “F” must be present in cow milk(R, 2001). One of the most complex materials that is organic is protein. They are composed of nitrogen, sulfur, oxygen, hydrogen, and occasionally phosphorus. There are two main proteins and trace amounts of additional proteins in milk's protein composition. Between them, casein and lacto albumin make up roughly 80% and 18% of the total *(*Samuel Abose, 2020). Adulteration is the deliberate addition, substitution, or removal of ingredients that negatively impacts the composition, character, and quality of food. The most prevalent adulterant in milk is water, which is frequently added to milk to enhance its volume for financial benefit. Water adulteration in cafeterias (2.30%) was higher than that of milk producers (1.08%) in samples that were randomly taken using a Lacto sensor. Using clot on boiling tests and alcohol perception, they also revealed that milk samples from households were of higher quality than those from cafeterias (Zebib *and* Zewdu,*2020*).

2.4.2. Physical Property of Milk

The pH of milk indicates its sanitary state and should be 6.6 or 6.8 at 20°C. This is because cooling milk lowers the chance of bacterial development, but high milk temperatures must be seen as conducive to bacterial growth in milk(FAO, 2017). A pH of 6.8 or above implies mastitis in milk, while a pH of 6.6 or lower shows elevated acidity in milk as a result of bacterial growth (Samuel Abose, 2020) . The specific gravity of a substance is its density divided by the density of water, the reference substance. Temperature affects a substance's density, hence when describing a certain density or gravity, the temperature must be mentioned. The specific gravity of milk is influenced by the composition, or ratio, of its ingredients. The addition of water lowers the specific gravity of milk, whilst the removal of fat and the dropping of temperature raise it. The typical range for milk's specific gravity is 1.027 to 1.035 grams per centimeter(Samuel Abosa, 2020). while according to (FAO ,2017)The typical specific gravity of milk is 1.026 to 1.032 g/cm3.

3. MATERIAL AND METHODS

3.1. DESCRIPTION of THE STUDY AREA

The study took place in Addis Ababa, the capital city of Ethiopia. According to recent estimates from the World Population Review, the city's population in 2023 is approximately 5.5 million, with a growth rate of 4.45%. Addis Ababa is administratively divided into eleven sub-cities, which consist of 118 woredas (districts). The city is located at a latitude of 9°1'48"N and 38°44'24"E, and it covers an area of 527 square kilometers (52,700 hectares), in the central highlands, with an average altitude of 2,355 meters (7,726 feet) above sea level. The area is characterized by a relative humidity ranging from 70% to 80% during the rainy season and 40% to 50% during the dry season. It has bimodal rainfall, with an average of 1200mm annually. The highest percentage of rainfall occurs during the long rainy season from June to September, while the short rainy season is from February to April. The annual average maximum and minimum temperatures are 22°C (72°F) and 10°C (50°F) (Alemayehu et al., 2020) respectively.

According to data the Addis Ababa Farmers And Urban Agriculture Development Commission (FUADC, 2023), the city's urban farms, are home to 20,114 dairy cattle, 3,596 beef cattle, 7,518 sheep, 458 goats, 90 swine farms, 175 fish farms, 1281 honey bee colonies, 570,031 poultry, and 135,329 day old chicks.



Fig 1. Map of the study area

3.2. SAMPLING TECHNIQUES and SAMPLE SIZE

3.2.1. Sampling Techniques:

Addis Ababa has eleven sub-cities, and three of them—Bole, Yeka, and Akaki Kality—were purposively selected for their potential for dairy farming and the presence of small and medium-scale dairy farms with milking cows. This selection may have been influenced by factors such as time, practicality, or logistical constraints. The decision to focus on only three sub-cities allows for a more concentrated analysis of specific farming practices and conditions. The farms were stratified by cattle size into two categories: small-scale (less than or equal to 5 cows) and medium-scale (more than 5 cows and less than or equal to 30 cows). This stratification, based on the classification proposed by Amare *et al*., (2019),helps capture variations in management strategies within different farm sizes. A simple random sampling approach was employed within each stratum to ensure a representative sample of farms. Farms were selected randomly using a random number generator to give each farm an equal chance of being chosen.

3.2.2. Sample Size

Yamane's (1967) formula, widely accepted for determining sample sizes, was used. This formula balances accuracy with cost-effectiveness and is based on a finite and large population sample size with 95% confidence and 0.05 precision levels, ensuring a representative sample size while maintaining precision. This standardized approach ensures better comparability of research findings across different studies. The formula used to obtain this sample size is presented as below.

$$n = \frac{N}{1+N(e)^2}$$

Where N=Population size,

e=expected error (level of precision) and

n= sample size

Number of farms in the selected sub city; - total number milking cows (N) =335

Yeka = 130 Akaki Kality= 170 Bole = 35

Thus, $n = \frac{335}{1+335\,(0.05)^2} = \frac{335}{1.84} = 182$

Therefore, 182 small scale and medium scale farms had been selected from 335 dairy farms found in three sub-cities and purposively selected districts.

In order to determine number of selected farms in each sub city and districts by using the following formula

$$No.Selected = \frac{\text{No. of dairy farm in each sub city}}{total\ no.of\ dairy\ farm\ in\ all\ sub\ city} \text{ x No. of sample size}$$

1. Bole proportion from the sample n = 35/335 X 182 = 19
2. Akaki kality proportion from the sample n = 170/335 X 182 = 92
3. Yeka proportion from the sample n= = 130/335 X 182 = 71

Table3. Proportionate distribution of dairy farms to districts

Selected sub-cities	Selected district	Number of dairy farms in each selected district	Proportion of dairy farms from the sub city	Number proportion included in the Sample	Proportion of farms **SS** were selected	MS were Selected
Bole	1	10	10/35 x19	5	4/10x5=2	6/10x5=3
	12	25	25/35x19	14	19/25x14=11	6/25x14=3
Akaki kality	7	78	78/170x92	42	41/78x42=22	37/78x42=20
	10	92	92/170x92	50	53/92x50=29	39/92x50=21
Yeka	9	47	47/130x71	26	8/47x26=4	39/47x26=22
	11	83	83/130x71	45	13/83x45=7	70/83x45=38
Total	6 districts	335		182	75	107

I.e. from the above selected districts the farm was selected randomly from the total farm found in the districts.

3.3. SOURCES OF DATA AND METHODS OF DATA COLLECTION

3.3.1. Sources of Data

This study used both primary and secondary data sources. The primary data were gathered from sample respondents through individual interviews, semi-structured questionnaires, and milk sample collection. Secondary data were collected from published sources such as the Addis Ababa Farmers and Urban Agriculture Development Commission Office, various farm records including milk yield, feed and feeding system, health records, dates of insemination, delivery records, as well as from different journals, previously conducted related research papers, reports, and publications from various associations connected to this topic, and relevant websites.

3.3.2. Methods of Data Collection

3.3.2.1. Data Collection

Survey

Semi Structured questionnaires were administered to farm owners or managers, covering topics such as feeding practices, housing conditions, milking techniques, breeding strategies, disease control measures, milk yield, and other farm activities. all included.

Milk sampling

A total of 30 fresh morning milk samples (60 ml) were collected directly from the milking containers immediately after milking, thoroughly mixed to ensure homogeneity, and then placed into the plastic sample-taking container that can hold 60 ml for analysis. Out of 30 milk samples, by the proportion, 12 were taken from 75 SS farms and 18 from 107 MS farms. The samples were collected from cows almost at the same stage of lactation, the same breed (HF cross), and parity. The samples were then transported to the FTVTI agro-processing laboratory to test composition parameters such as F, P, L, SNF, TS, density, mineral content, and PH by using a lactoscan machine. Testing the Milk Composition:

Instrument Preparation:

. Power on the Lactoscan machine and allow it to warm up. Perform a calibration using distilled water to obtain accurate results.

. Follow the machine's calibration protocols to ensure precise readings.

Sample Analysis:

. If the samples are cold and frozen, let them come to room temperature. Then, pour the milk sample into the sample chamber or insert the sample container into the designated slot on the Lactoscan.

Data Acquisition:

. The Lactoscan machine will automatically analyze the milk sample and display the analysis results on the screen, record the mentioned parameters value by replicating it three times then take the mean value of each sample for analysis.

Cleaning and Maintenance:

. After the analysis, clean the sample chamber or any parts that came in contact with the milk using distilled water.

. Perform regular calibration of the Lactoscan machine to ensure consistent and accurate results.

3.4. Method of Data Analysis

Once the data were collected, they were organized, cleaned, and exported to Excel. Afterward, the data were transferred to the Statistical Package for the Social Sciences (SPSS), version 20, for analysis. The analysis involved using descriptive statistics such as frequency distribution and percentages to examine the data, as well as conducting an independent T-test to compare the mean milk yield of dairy cows and milk composition. All tests were carried out with a 95% confidence level ($p < 0.05$). The qualitative data were used to enhance and provide context to the quantitative findings.

4. RESULT AND DISCUSSION

4.1 RESPONDENT CHARACTERISTICS

According to the data in Table 4, in MS farms, 80.4% of the respondents were male, while 19.6% were female. In SS farms, 73.3% of the respondents were male, while 26.7% were female. Across both farm sizes, 77.5% of the respondents were male, while 22.5% were female. Therefore, it is evident that males participate more than females in dairy farming activities in the study area, regardless of farm size. This study lined with Bongase (2020), who reported that male respondents were dominant among both smallholder farmers and micro-enterprises (71.25%) in Sebeta town Similarly, Jebessa *et al*., (2024) found that 82% of the sample households were headed by males in Jimma zone, Ethiopia and According to Jalel *et al*., (2020) closer gender participation was observed in the Oromia special zone around Addis Ababa, where 47.8% of the surveyed dairy farms were owned by female households, while 52.2% were owned by male households. In contrast Hailemariam *et al.,* (2023) found that majority (60.8%) of the dairy farms were run by females in the Dilla Zuriya district, Gedeo Zone, Ethiopia.

SS farms did not have any respondents in the age range of 18-28, suggesting that most SS farms were traditionally operated at the household level by elderly individuals. Near to their living house, a long time ago. In contrast, MS farms had a small percentage of respondents in this age range (6.5%). Generally, the majority of respondents were in the age range of 40-50, constituting 48% in SS farms and 46.7% in MS farms. This finding is consistent with Hatew *et al*., (2023), the majority of the respondents were found to be in the productive working-age category of 18-55 years among Ethiopian smallholder farmers. It also similar to the finding of Aleganesh *et al*., (2019) who reported productive age group was dominants for dairy production in central highlands of Jimma. This suggests that the sector can provide job opportunities and serve as a source of income generation for a wide range of age groups. These might be due to the active involvement of physical involvement required by the farming system and the fact that dairy farms required a higher investment and a longer time to accumulate wealth before being engaged in dairy business.

Table 4 Respondents Characteristics

Variables		Farm Size					
		Medium scale (n=107)		Small scale (n=75)		Over all (n=182)	
		Frequency	%	Frequency	%	Frequency	%
Sex	Female	21	19.6	20	26.7	41	77.5
	Male	86	80.4	55	73.3	141	22.5
Age of respondent	18-28	7	6.5	-	-	7	3.8
	29-39	14	13.1	14	18.7	28	17.0
	40-50	50	46.7	36	48	86	47.3
	Above 50	36	33.6	25	33	61	31.9
Marital status	Married	70	65.4	61	81.3	131	70.9
	Single	25	23.4	8	10.7	33	18.7
	Widow	7	6.5	3	4	10	6.0
	Divorced	5	4.7	3	4	8	4.4

Based on Table 4, 81.3% of respondents in SS farms were married, which is a result similar to that, reported by Samuel Abose, (2020), where 86.1% of smallholder farmers were married in Sebeta. In MS farms, the percentage is 65.4%. This is because older individuals typically manage SS farms, while younger farmers operate MS farms. Starting a dairy business today is costly, which is why young individuals are establishing dairy farms in cooperatives to address financial constraints and land access issues.The percentage of unmarried respondents is higher in MS farms (23.4%) compared to SS farms (10.4%). Out of all the respondents, 70.9% were married, which differs from the findings of Ketema Worku, (2014)), where all respondents were married in Kersa Malima Woreda, Oromia regional state. The current findings closely align with the study by Abagero,

(2016), which showed that 64% and 76% of individuals were married in urban and rural areas, respectively, in the Agarfa district of the Oromia regional state in Ethiopia. Additionally, 18.7% of respondents were single, 6.0% were widowed, and 4.4% were divorced across both farm sizes in the current study.

Figure 2: shows that the majority of the population, especially the MS group, has completed elementary education (43.9%), followed by high school (22.4%). The SS group has a higher percentage of elementary education (30.7%), followed by high school (29.3%), with 14.7% having reading and writing skills and 14.7% holding a diploma. Overall, 37.9% of the population has completed elementary education, followed by 26.4% with a high school education, and 3.8% hold a degree or higher in the study area. The data suggests that formal educational achievement is linked to the size and commercial focus of dairy farms.

The study results are lower than those of Amare et al., (2019). Their study on Production system characterization of large, medium, and small-Scale dairy farms in Ethiopia reported that the majority of dairy producers (45.00% for large-scale, 67.06% for medium-scale, and 66.67% for small-scale producers) had completed high school, resulting in an overall percentage value of 58%. Additionally, 40.00% of large-scale producers, 8.24% of medium-scale producers, and 6.31% of small-scale producers had a university education, averaging at 18%. It's clear that education plays a significant role in influencing household income, technology adoption, demography, health, and overall socio-economic status in the country.

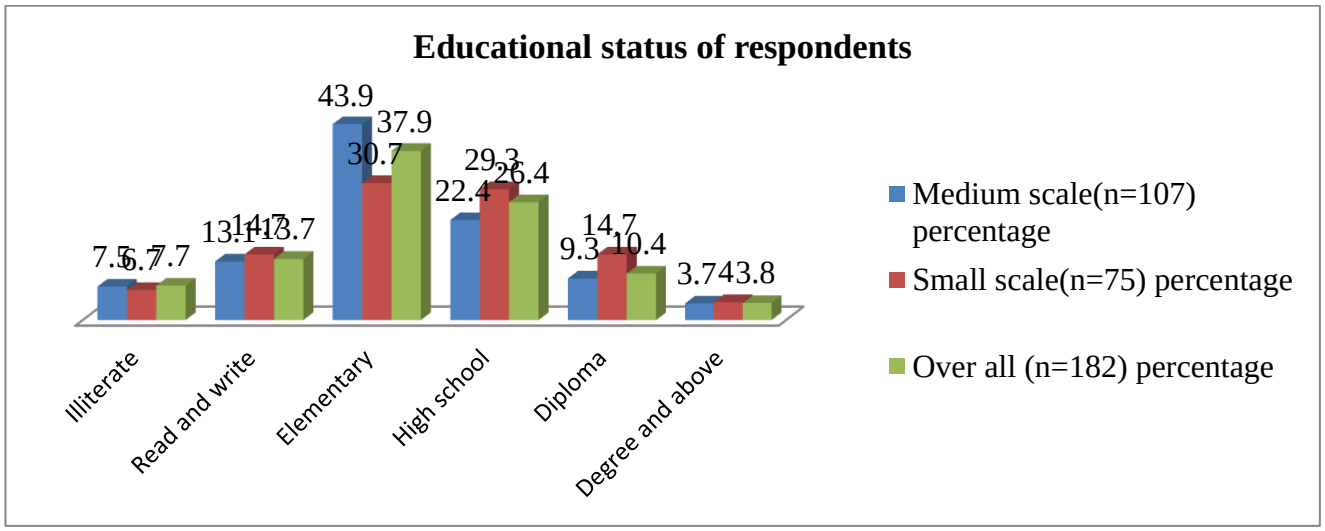


Fig 2. Educational status of respondents

Figure 3: shows evident that the majority of farms, 74.8% in the MS group and 72% in the SS group, are owned by individuals with more than 5 years of experience. This finding is in lined with Abagero, (2016) farmers that had long experience of cattle rearing, proportionately greater percentage rural (73.3%) than in peri-urban (37.3%) dairy production system in the Agarfa district of Oromia regional state, Ethiopia. Additionally, there are a significant percentage of farms owned by individuals with 3 to 5 years of experience. This study is consistent with the findings of Jalel et al., (2020), where farming experience ranged from 1 to 10 years in urban dairy production and waste management in the Oromia special zone around Finfine, Ethiopia. Farming experience generally correlates positively with farm success and productivity. Farming experience generally correlates positively with farm success and productivity.

Correlation between Experience and Success

Knowledge and Skills: Experienced farmers have honed their skills over time, enabling them to make informed decisions.

Problem-Solving: With experience comes familiarity with common challenges such as weather variability, disease outbreak, feed shortage and cost fluctuation. Experienced farmers are often better equipped to handle such problems.

Networking: Seasoned farmers typically have established networks for sharing information, resources, and market access, which can enhance productivity.

Financial Management: Experienced farmers may have better financial management skills, allowing for more effective investment in equipment, technology, and inputs that boost productivity.

Data on Newer Farms

Productivity Levels: Newer farms may face initial challenges such as lower productivity due to a lack of experience. Research indicates that younger or newer farmers often yield less in their first few years compared to established farms.

Adoption of Technology: Newer farms, particularly those run by younger farmers, may adopt modern technology and practices more readily, which can lead to improved productivity over time.

Challenges Faced: Newer farmers often encounter barriers such as:

Access to Capital: Limited financial resources can hinder investment in necessary equipment and technology.

Market Access: New entrants may struggle to establish market connections and brand recognition.

Knowledge Gaps: Lack of experience can lead to inefficient practices and mistakes.

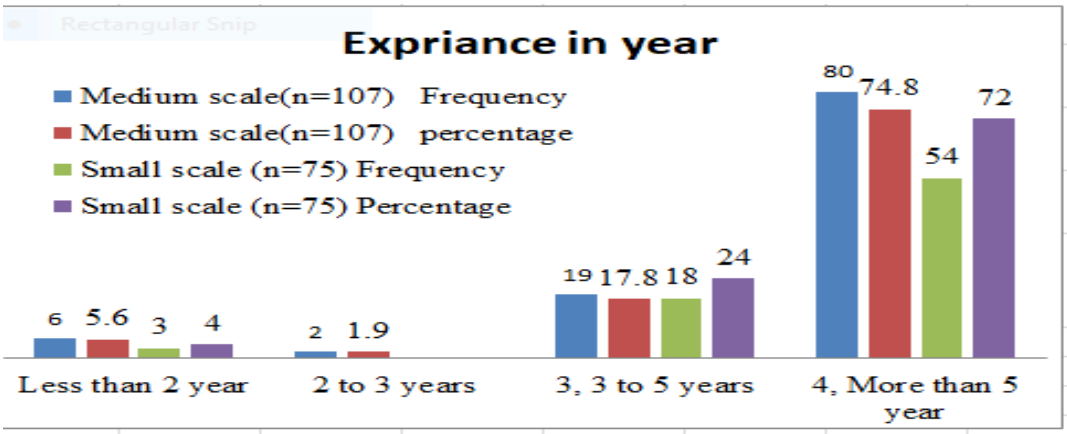


Figure 3, Farming experience in the study area

4.2 GENERAL FARM INFORMATION

Table 5 shows that the majority of dairy farms in both the MS and SS categories are owned by individuals (78% and 90.7% respectively). This finding aligns with the report of FUADC, (2023) which indicated that dairy producers ask for land when they are assisted to organize and a dairy association. However, access to land is very limited in the sub-city and it not within the mandate of the Woreda Agri Bureau mandate to grant land in Addis Ababa.

It is possible that farmers in the study area prefer to work individually rather than in a cooperative because most farmland is owned by individual households rather than collectively. Additionally, much of the farmland was quite small, making it more practical for individual households to farm alone rather than in a larger cooperative. Farmers often prefer to retain direct control and decision-making power over their own land. Individual farming allows farmers more flexibility in their farming methods, and there have been problems with mismanagement or corruption in some agricultural cooperatives. However,

the proportion of cooperatively managed farms is higher in the MS group (21.5%) than in the SS group (9.3%).

The results of the study indicate that milk production positive impact on the livelihoods of households, as the income generated from milk is sufficient for both the family in addition to personal consumption. In addition, dairy farming has created employment opportunities for smallholder micro-enterprises, which are dominated by the young population. Dairy farming requires higher investment and it may take longer to accumulate assets before one is now an individual in dairy farming. Cooperative dairy farms have better access to inputs such as feed, veterinary services, credit, land and extension services. They also have a better bargaining position when selling milk and procuring inputs, as well as easier collective action and better knowledge sharing among farmers. overall 84.35% of farms owned individually, and 15.4 % are cooperative in the study area, aligning with the finding of Fesseha, (2020) which showed that the majority of visited dairy farms in Wolaita Sodo, Southern Ethiopia were private-owned (81.37%) with, (17.65%) cooperative.

The data in Table 5 show that the majority of dairy farms in both the MS (93.5 %) and SS (94.7 %) categories kept crossbred or HF crossbred cattle over other exotic dairy breeds. The combination of productivity, adaptability, availability and farmers' experience with crossbred cattle, especially HF crosses, explains the high preference for these animals over other exotic dairy breeds in Addis Ababa dairy farms. 6.5% of MS farms and 5.3% of SS farms kept a mixture of native and crossbred cattle on their farms.

The data in Table 5 indicates that most farmers, in both the MS and SS groups, are uncertain about the blood levels of their dairy cows. Only a few farms know the blood levels of their cattle, with just one farm in the medium scale group reporting a blood level of 25-50%. These findings are consistent with Senbeta and Galmesa (2023) where the majority of farm owners were unaware of the precise exotic gene inheritance of their crossbreed cows. Holstein Friesian crosses dominated all farm categories in Dire Dawa and Harar Cities, Ethiopia. The current findings indicate that dairy farming in Addis Ababa faces several challenges related to blood levels. These challenges include a lack of record-keeping, informal breeding practices, limited access to breeding information, financial constraints, and cultural practices and priorities. Uncertainty about blood levels complicates dairy farming practices, impacting health management, reproductive performance, milk quality, and economic outcomes. To address these challenges, farmers

can invest in regular monitoring, enhance their knowledge of blood parameters, and implement best practices for herd management.

Table5, General Farm Information

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Type of dairy farm owner	Individual	84	78.5	68	90.7
	Cooperatives	23	21.5	7	9.3
Breed or variety of the dairy cattle kept	Mixed (local and cross within the farm)	7	6.5	4	5.3
	Cross breed	100	93.5	71	94.7
The blood level of your dairy cattle	Don't now	106	99.1	75	100.0
	25 – 50%	1	.9	**0**	**0**

4.3 HOUSING MANAGEMENT STRATEGIES

The latest survey of MS and SS dairy farms shows that all farms used conventional barns. This study observed a higher percentage stanchion housing type percentage than the report by Jalel *et al*., (2020) on urban dairy production and waste management in the Oromia special zone around Finfine, which was 81.1%. However only 12.1% and 14.7% of MS and SS farms, respectively, had barns specifically designed for cows. Lined with the study by FUADC, (2023) which noted that cows are confined together on concrete floors in Addis Ababa sub city and with Sander *et al*., (2021) who reported that farms often face limited or no access to pasture land, feed, or fodder.

Employees in this production system typically have better access to inputs, veterinary care, and more commercial management practices. This system is responsible for about

half of the premium breeds and crossbreeds. In contrast with (FAO,2019) shown that dairy housing systems with access to pasture, such as tie stalls and free stalls, can improve cattle welfare. Also other studies shows that in Ethiopia urban and peri-urban dairy farms used a variety of housing systems, from individual housing to separate barns (Ayalew and Abatenhe; (Abebe Kiros *et al*.); (Feleke *et al.*, 2016); (Gizaw et al.), (Alemu, 2019).

Table 6 Housing management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Do you use convectional housing (Tie barn) in your farm?	Yes	107	100%	75	100.0
Is a barn designed to provide adequate space?	Yes	13	12.1	11	14.7
	No	94	87.9	64	85.3
Is there proper air flow to maintain air quality and prevent heat stress?	Yes	76	71.0	50	66.7
	No	31	29.0	25	33.3
Are there appropriate lighting conditions that promote cow activity and comfort?	Yes	98	91.6	62	82.7
	No	9	8.4	13	17.3
Have you implement regularly inspecting and maintaining the barn structure, equipment, and facilities?	Yes	66	61.7	30	40.0
	No	41	38.3	45	60.0

Regarding to air flow 29% of medium-scale farms and 33.3% of small-scale farms lacked proper airflow in their barns. The majority of farms had suitable lighting conditions, but 8.4% of medium-scale and 17.3% of small-scale farms lacked adequate lighting. Concerning regular inspection and maintaining the barn structure, equipment, and facilities were 61.7% of MS farms regularly inspected and maintained their facilities, while 60% of SS farms did not prioritize maintenance. Table (6) this shows the contrast between the maintenance practices of MS and SS farms highlights

potential differences in resources, knowledge, or priorities that influence the level of facility upkeep.

Environmental factors like temperature and humidity have a significant impact on dairy cattle health, growth, and milk production Mylostyvyi & Chernenko (2019), ; Zhu et al., (2020). Generally the current study shows on barn features like airflow and lighting in MS and SS farms, providing granular data on dairy facilities, contrasting previous research that examined broader dairy housing systems.

4.4 FEEDING MANAGEMENT STRATEGIES

Out of MS farms, 100% have a consistent feeding schedule and access to fresh feed. In SS farms, 96% follow a consistent schedule. All MS and SS farms minimize feed waste and provide cows with grain (concentrate), this result is similar to the study in the urban and peri-urban areas of Holetta, Bishoftu, Sululta, and Assela primary feed and feeding practices where stall feeding and restricted grazing also contradict the study In the municipalities of Bishoftu and Akaki, the percentage of dairy owners that used stall feeding in combination with restricted grazing feeding methods was 75.6% and 25.4%, respectively (Tolasa *et al.*, 2020).

None of farms manage MS fodder crop cultivation, while 5.3% grow and store SS crops. Concentrates are added to daily diets on both MS and SS farms this study is agreed with the result of (Jalel *et al*.), In Bishoftu, the main sources of feed were concentrates (such as noug cake and wheat bran), agricultural waste, stored hay, certain forage legumes (similar to some SS farms), and vegetable and fruit wastes. The study result in Addis Ababa showed that the two most common feed types were hay and wheat bran (Alemu, 2019) and the three most significant concentrate supplements are nug cake, commercial concentrate mix, and wheat bran(Duguma, 2022) in Jima town the study revealed that the majority of farms in the SS and MS regions use brewery by-products as feed to increase daily milk yield. Specifically, 60.7% of MS and 58.7% of SS farms utilize brewery by-products to improve yield. Additionally, 26.75% of MS farms and 17.3% of SS farms use concentrate feed, while 0.9% of MS farms and 2.7% of SS farms use grain filter feed. Furthermore, 5.6% of MS farms and 10.7% of SS farms use green forage, and 9.3% of MS farms and 10.7% of SS farms utilize vegetable by-products as a supplement to increase yield. All of the farms rely on purchased feed resources similar to (Ketema Worku, 2014) Urban dairy farmers often rely heavily on purchased concentrate feeds, such as wheat bran, oilseed

cakes, and commercial dairy rations, to supplement the limited availability of on-farm feed resources.

Table 7 Feeding management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Have your farm follow a consistent feeding schedule and access to fresh feed?	Yes	107	100.0	72	96.0
	No	-	-	3	4.0
Do you minimize feed waste and properly provide the cows with their grain?	Yes	107	100.0	75	100.0
	No	-	-	-	-
Oversee the growing, gathering, and storing of fodder crops? If it exist.	Yes	-	-	4	5.3
	No	107	100.0	71	94.7
Did you add concentrates to forage diet? To meet the needs for protein and energy requirement of dairy cow.	Yes	107	100.0	75	100.0
	No	-	-	-	-
Have you formulate ration for your dairy cattle that satisfy the needs of the cows?	No	107	100.0	75	100.0
Did you monitor feed efficiency, cow performance, milk production, and feed intake?	Yes	107	100.0	75	100.0
Did you Store feedstuffs correctly to preserve their nutritional value?	Yes	21	19.6	26	34.7
	No	86	80.4	49	65.3
Use the by-products as animal feed?	Yes	107	100.0	75	100.0

Table 8 Types of feed that enables the farms to produce more milk

Variables	Medium scale (n=107)			Small scale (n=75)		
	Frequency	%	Rank	Frequency	%	Rank
Brewery by product	65	60.7	1	44	58.7	1
Concentrate feed	25	26.75	2	13	17.3	2
Grain filter	1	0.9	5	2	2.7	5
Green forage	6	5.6	4	8	10.7	3
vegetable by products	10	9.3	3	8	10.7	3

The study also revealed that none of the farms in the study area had formulated a ration that met the needs of their cows. The main reason for this is that collecting each ingredient for formulating rations is tedious, and getting all ingredients from one source is a challenging activity. Therefore, farmers prefer to use formulated rations. All the farms monitored feed efficiency, cow performance, milk production, and feed intake, and used by-products as feed. Notably, small-scale farms were found to have better storage of feedstuffs compared to MS farms due to having more available space relative to the number of cows kept. Feed storage practices in SS farms utilize local materials to ensure efficient feed storage, with a focus on preservation and quality. Traditional practices and community knowledge play a crucial role in establishing effective storage methods. Proper storage minimizes spoilage and contamination, ultimately ensuring high-quality feed. This, in turn, improves cattle health, milk production, and profitability. Economically, these practices lead to cost efficiency and market competitiveness, as higher-quality products can command better prices, thus enhancing the economic viability of SS farms.

4.5 WATERING MANAGEMENT STRATEGIES

The study found that all 100% of MS farms had unrestricted access to clean, fresh water, while 4% of SS farms had no access. Only 0.9% of MS farms installed automatic waterers. All farms offered clean troughs and waterers, with 11.2% of MS and 5.3% of SS placing water sources in accessible regions. All farms had contingency plans in place for water system failures or emergencies. The recent findings differ from the overall results of a

study by Kiros *et al*. (2018), which found that 17.5% of urban and 11.3% of peri-urban areas in Assela, Bishoftu, Holetta, and Sululta provide unlimited water for dairy cattle. This contrasts with a study in Adigrat, Tigray by Alemshet (2014), which reported that 28.9% of respondents in urban and 15.25% of respondents in peri-urban areas provide unlimited water for dairy cows.

Table 9 Dairy cattle watering management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Clean and fresh water accessibility	Unrestricted	107	100.0	72	96.0
	Restricted	-	-	3	4.0
Have you Installed automatic waterers that provide a constant supply of clean water?	Yes	1	0.9	-	-
	No	106	99.1	75	100.0
Did you Provide clean and well-maintained troughs or waterers that are free from contaminants and debris?	Yes	107	100.0	75	100.0
	No	-	-	-	-
Do you install Strategic Placement of water sources in easily accessible areas?	Yes	12	11.2	4	5.3
	No	95	88.8	71	94.7
Contingency plans in place in case of water system failures or emergencies?	Yes	107	100.0	75	100.0
	No				

Overall, the current results indicate that MS dairy farms generally have better water access and management practices than SS dairy farms. The lack of automatic water systems and the placement of water sources in inaccessible areas on SS farms may indicate challenges with water infrastructure and resource constraints faced by smaller operations. SS farms select manual watering due to lower water demand, operational simplicity, limited access to technology, infrastructure challenges, a hands-on approach, time management, concerns about functionality, and a preference for control, and resistance to new technologies due to traditional practices. However, the fact that all farms had contingency plans shows an awareness of the importance of reliable water access for dairy cattle. Water quality is crucial for milk production and animal health in dairy farming. Insufficient water intake can decrease milk yield, affect milk composition, prevent diseases, aid digestion, and support metabolic processes. Economic implications include increased veterinary costs and lower productivity, while high milk quality is essential for market acceptance.

4.6 HEALTH CARE MANAGEMENT STRATEGIES

The study reveals that 107 farms (100%) and 74 (98.7%) in MS and SS farms respectively monitor cows for signs of illness, injury, or disease which is essential for early detection and treatment of health issues. While only 1.3% or 1 farm does not in SS farm. In MS and SS farms, all MS and 98.7% of SS farms implement vaccination programs to protect their cows from infectious diseases. Regular inspection and maintenance of hooves are performed by all MS and 98.7% of SS farms prevent lameness and other issues. All farms monitor and manage cows' reproductive health to ensure high breeding success rates, these results are consistent with Fesseha (2020)health management, most respondents use (97.06) regular veterinary consultancy in Wolaita Sodo, Southern Ethiopia and nearly lined with (Abunna, 2019) (88.24%) were explained that the practice of vaccination to control the occurrence of diseases was done by the health technicians employed in the Selected Sub Cites of Addis Ababa, Ethiopia . 9.3% of MS farms have established procedures to prevent and handle udder irritation or mastitis, while 90.7% and 93.3% have not. All farms have implemented measures to prevent and treat both internal and external parasites. Contradict the result of Alemu (2019), The most prevalent medical conditions that were noted were diarrhea (50.7%), respiratory problems (48.8%), and external parasite infestation (87.6%). The majority of farms had tick infestations (76.1%), which were followed by mange mite infections (17.9%), lameness (61.2%), and different basic and/or complex wound concerns (23.9%) not observed in the current study.

Table 10 Dairy health care management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Did you monitor individual cows or the entire herd for signs of illness, injury, or disease?	Yes	107	100.0	74	98.7
	No			1	1.3
Have You Implement vaccination programs to protect your cows from infectious diseases?	Yes	107	100.0	74	98.7
	No			1	1.3
Regularly inspect and maintain your dairy cows' hooves to prevent lameness and other related issues?	Yes	107	100.0	74	98.7
	No			1	1.3
Did you Monitor and manage the cows' reproductive health to ensure high breeding success rates?	Yes	107	100.0	75	100.0
Have you established procedures to prevent and handle udder irritation or mastitis in your farm?	Yes	10	9.3	5	6.7
	No	97	90.7	70	93.3
Implement measures to prevent and treat both internal and external parasites?	Yes	107	100.0	75	100.0
Collaboration with Veterinarians?	Yes	107	100.0	74	98.7

The latest study indicates that 1.9% of MS and 5.3% of SS farms experienced calf loss due to diarrhea. Additionally, 5.6% of MS and 6.6% of SS farms faced disease issues, particularly hypocalcemia in dairy cows. The findings suggest that both MS and SS dairy farms generally maintain high levels of animal health and welfare practices, with

variations in the implementation of specific procedures for udder health management. This improvement is noteworthy, as mastitis remains a common and costly problem in dairy farming.

4.7 BREEDING MANAGEMENT STRATEGIES

All 107(100%) MS farms use AI techniques for breeding; Also 74(98.7%) farms use AI techniques in small-scale farms agree with urban and peri-urban districts of Holetta, Bishoftu, Sululta, and Assela AI was the primary breeding technique Kiros *et al*. (2018) contrast results with Alemu (2019), in Addis Ababa, the AI method accounts for 77.4% of the mating system due to its accessibility, while NM is used by 3% of the population and AI by 19.4% of the population, Tolasa et al. (2020) shows in the towns of Bishoftu and Akaki, AI is utilized by 50.8% and 46.4% of farms, respectively, to produce dairy cattle, (Feleke et al.) indicated that 35% of the households in Boditti town's mixed crop/livestock production system use AI, 65.4% of the families use natural mating (NM) with local bulls, and 1.7% use both natural mating and AI service, Aseged *et al*. (2023) Showed that NM is the only way dairy farmers in the Metekel zone of northwest Ethiopia utilize to inseminate their cows. In the Borana zone, 84.2% of mid-highland and 75.2% of lowland regions, on average, used natural bull service for breeding Takele Gebissa (2014). Only 0.9% use AI and NM techniques for breeding in SS farms. 8.4% of MS farms choose genetically superior sires and allow for controlled genetic improvement also access to sex-sorted semen but it is costly ranging from 3000-5000 per service, while 91.6% of MS and 85.3% of SS do not. All farms do not conduct examinations of bulls and cows to ensure successful breeding. 100% of MS and 98.7% of SS farms implement methods to accurately identify cows in heat for timely insemination, which was a similar result with Kiros *et al*. (2018) urban and peri-urban districts of Holetta, Bishoftu, Sululta, and Assela all detect estrous, while 1.3% of small-scale farms do not. Synchronization protocols are used by 0.9% of medium-scale farms. All farms diagnose pregnancy status in cows to identify open cows and manage breeding outcomes, while only 1.3% does not. The result shows that high level of adoption of reproductive management practices, such as AI, breeding potential evaluation, and pregnancy diagnosis, on both MS and SS dairy farms. However, there are some differences in the implementation of specific practices, such as sire selection for genetic improvement and the use of synchronization protocols. These variations may be influenced by factors like farm resources, access to technology, and management priorities.

Table 11 Breeding management

Variables			Medium scale (n=107)		Small scale (n=75)	
			Frequency	%	Frequency	%
Mating system	AI techniques		107	100.0	74	98.7
	NM technique		1(NM & AI)	0.9	1	1.3
Did you choose genetically superior sires and allowing for controlled genetic improvement?		Yes	9	8.4	11	14.7
		No	98	91.6	64	85.3
Did you conduct examinations of both bulls and cows to ensure their ability to breed successfully?		No	107	100.0	75	100.0
Did you implement methods to accurately identify cows in heat for timely insemination?		Yes	107	100	74	98.7%
		No			1	1.3%
Employ synchronization protocols to optimize the timing of heat?		Yes	1	0.9		
		No	106	99.1	75	100.0
Did you diagnose pregnancy status in cows to identify open cows and manage breeding outcomes?		Yes	107	100.0	74	98.7
		No			1	1.3
Did you evaluate and adjusting the breeding program based on performance outcomes and genetic progress?		Yes	107	100.0	74	98.7
		No			1	1.3

4.8 MILKING MANAGEMENT STRATEGIES

The study in table (12) found that all farms in the study area implemented cleaning and sanitizing practices for the udder and teats before milking, contrast the result of Amare *et*

al.(2019) in Dire Dawa, Harar, Haramaya University, Bishoftu, Holeta Agricultural Research Center, and Mekele dairy farms in Ethiopia, most farmers (76% for large scale and 87.50% for medium scale) washed the udders of the cows before milking. However, in small-scale dairy farms, the majority (54.05%) did not wash the udders of the dairy cows before milking and also the result of Abunna (2019) about 25.7% of them never wash udder (teats) and did not clean barns before milking in Addis Ababa, Ethiopia.

Maintained a consistent milking routine farms, 98.1% and 100% of farms regularly inspected, cleaned, and maintained milking equipment, respectively. However, only 1.9% implemented suitable teat dip or post-milking treatment. In medium-scale farms, 99.1% and 98.7% had a clean and hygienic milking parlor, while 0.9% and 1.3% did not. Surfaces and equipment disinfection was infrequent in both medium-scale and small-scale farms. All farms established a consistent milking schedule similar to Hailemikael et al. (2019) the majority of Ethiopian rural households milk their cows twice a day, in the morning and the evening. However, the implementation of suitable teat dip or post-milking treatment is rare in both categories.

The data shows in table (12) high adoption of advised milking management techniques on dairy farms, including udder preparation, routines, and equipment maintenance. However, variations exist due to factors like resources, technology, and managerial priorities. Mastitis remains the leading cause of illness in highly producing cow in the city.

Table 12 Milking management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Have you implemented cleaning and sanitizing the udder and teats before milking to ensure clean milk yield?	Yes	107	100.0	75	100.0
Did you maintain a consistent milking routine that included gentle and efficient milking?	Yes	107	100.0	75	100.0
Regularly inspecting, cleaning, and maintaining milking equipment to ensure proper functioning and prevent contamination?	Yes	105	98.1	75	100.0
	No	2	1.9		
Suitable teat dip or post-milking treatment to protect the teat end from bacteria and promote udder health?	Yes	2	1.9		
	No	105	98.1	75	100.0
Was your milking parlor clean and hygienic?	Yes	106	99.1	74	98.7
	No	1	0.9	1	1.3
Were surfaces and equipment's regularly disinfected?	Yes	1	0.9		
	No	106	99.1	75	100.0

4.9 WASTE CONTROL MANAGEMENT STRATEGIES

A higher percentage of (SS) farms implemented appropriate waste storage systems and handling practices than (MS) farms. This difference was attributed to the uneven land and the number of dairy cattle they had. The study also revealed that none of the farms in the study area utilized animal dung as an energy conservation method for electric supply. Compliance with national regulations was relatively high in both categories, with slightly higher compliance reported by SS farms. Overall, SS farms demonstrated a higher implementation rate for waste storage systems and handling practices than MS farms. These findings are consistent with the results of Amare *et al*. (2019) in large-scale dairy farms and with FUADC, (2023) Urban dairy production faces challenges in managing

organic waste due to limited land access and residential areas. Farm size, access to land, and production systems influence waste management practices. Manure management is a challenge, particularly for producers with limited space. Different disposal methods include dumping in rivers, giving to workers, or using it as organic fertilizer. Overall, manure handling, drainage, and disposal are poor, and biogas digesters are rare in Addis Ababa sub city. The majority (47.50%) of the drainage systems in these farms were poor due to uneven land and the number of dairy cattle they had. In contrast, SS (75.68%) and MS (62.35%) dairy farms had relatively satisfactory drainage systems. Composting techniques were more common in SS farms. Both farms in the current study reported that they were unable to use animal dung for generating electricity.

Table 13 Dairy cattle waste control management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Did you implement appropriate waste storage systems and handling practices?	Yes	44	41.1	40	53.3
	No	63	58.9	35	46.7
Did you take measures to reduce odor from manure storage, such as covering it or using odor-reducing additives?	Yes	100	93.5	63	84
	No	7	6.5	12	16
Have you used composting techniques to convert manure and organic waste into valuable soil amendment?	Yes	29	27.1	42	56
	No	78	72.9	33	44
Is there away install biogas plant for electric service by using animal dung?	No	107	100	75	100
National regulations related to waste management and ensuring compliance with relevant standards?	Yes	100	93.5	62	82.7
	No	7	6.5	13	17.3

4.10 FARM RECORD KEEPING STRATEGIES

The data shows in table (14), that 15.0% of MS farms maintained detailed records of cow health, while 85.0% and 78.7% did not. All 107 MS farms and 73 SS farms recorded daily milk production data, while 2.7% did not. 99.1% of MS farms tracked breeding dates, heat detection, pregnancy diagnosis results, and calving information. similar result with Kiros *et al*.(2018) Milk yield, service and calving dates were the main parameters recorded in peri-urban Holetta, urban Sululta, urban Bishoftu, urban Holetta, peri-urban Bishoftu and peri-urban Sululta, Only 3.7% of MS farms documented feed composition, feeding practices, and nutritional information. The majority of MS farms, 96.3%, and 94.7% in SS farms did not. 16.8% of MS farms kept track of expenses, income, and financial transactions, while 83.2% and 70.7% of MS and SS farms did not. 14.0% and 14.7% of MS and SS farms maintained records of herd inventory, respectively. Contradict with SNV (2017) found that many dairy producers did not keep their records up to date; similarly Feleke *et al.* (2016) reported that 95% of dairy producers in Boditti town cited a miss understanding of the benefits of record-keeping as the main reason for the lack of it.

The current study suggests more widespread record-keeping, especially for key parameters like daily milk production, breeding, and calving. However, the study still found significant gaps in areas like feed management and financial records, which aligns with the literature's findings on the overall lack of comprehensive record-keeping on many dairy farms.

Table 14 Dairy cattle record keeping management

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Did you maintain detailed records of cow health, including vaccinations, treatments, and health events, to monitor individual and herd health status.	Yes	16	15.0	16	21.3
	No	91	85.0	59	78.7
Did you record daily milk production data for each cow?	Yes	107	100.0	73	97.3
	No			2	2.7
Did you tracking breeding dates, heat detection, pregnancy diagnosis results, and calving information.	Yes	106	99.1	73	97.3
	No	1	0.9	2	2.7
Did you document feed composition, feeding practices, and nutritional information?	Yes	4	3.7	4	5.3
	No	103	96.3	71	94.7
Did you keep track of expenses, income, and financial transactions to assess profitability, manage costs, and aid in financial planning?	Yes	18	16.8	22	29.3
	No	89	83.2	53	70.7
Did you maintain records of herd inventory, including the number of animals, deaths, and culling, to make management decisions?	Yes	15	14.0	11	14.7
	No	92	86.0	64	85.3

4.11 CHALLENGES OF THE FARM

The study reveals that both MS and SS farms face challenges such as animal disease (5.6% and 6.6%), calf mortality (1.9% and 5.3%), cost of animal feed (1.9% and 10.6%), lack of quality and quantity feed (2.8% and 6.7%). The study lined with Ayza *et al*., (2013)waste disposal areas are a major challenge in Boditti town, with MS at 80.3% and

SS at 60%. Other challenges identified in the study include water accessibility (1.9% and 4%), land availability (2.8% and 4%), and administration restrictions (2.8% and 2.7%) in MS and SS farms, respectively. Contrast the result of Delaeb (2023) the major factors associated with milk production were the high feed price (35%), lack of improved breed, lack of technical support, lack of adequate marketing, Disease outbreaks (16%), and lack of improved milking utensils. Common concerns faced by farmers are crucial for animal welfare, production optimization, and overall farm productivity and sustainability. Addressing these challenges is essential for ensuring animal welfare, optimizing production, and enhancing overall farm productivity.

Table 15 Challenges of the farm

Variables	Medium scale (n=107)			Small scale (n=75)		
	N	%	Rank	N	%	Rank
animal disease	6	5.6	2	5	6.6	4
calf mortality	2	1.9	5	4	5.3	5
Cost of animal feed	2	1.9	5	8	10.6	2
Lack of quality and quantity feed	3	2.8	3	5	6.7	3
Lack of waste disposal area	86	80.3	1	45	60	1
Lack water accessibility	2	1.9	5	3	4	6
Shortage of land availability	3	2.8	4	3	4.0	6
The authorities not allowed to farmers for modify farm design.	3	2.8	4	2	2.7	7

4.12 MILK YIELD

In table (16) shows MS farms of 41.1% and in SS farms of 33.3% farms use individual cow milk recording to measure milk yield. On the other hand 58.9% of MS farms and 66.7% of SS farms use bulk tank measurement. It's worth noting that most dairy owners rely on wage employees for milking their cattle and prioritize timely milking over measuring each cow's performance in this particular area of research.

In both medium-scale and small-scale farms, there are variations in milk yield across different lactation stages. This indicates that milk yield in dairy cows fluctuates due to physiological and hormonal changes, affecting both medium-scale and small-scale farms, despite consistent physiological changes across breeds and management systems.

Furthermore, both medium-scale and small-scale farms experience seasonal variations in milk yield. These changes are influenced by seasonal factors such as temperature, humidity, and feed availability. High temperatures can cause heat stress, reducing feed intake and milk production, while cooler months offer better comfort and feed utilization. It's important to note that these seasonal variations in milk yield are common across medium-scale and small-scale farms, affecting both types of farms.

The table (16) presents the Daily Milk Yield data; showing that the average daily milk yields for MS farms were 13.93 ± 3.16 liters, while for SS farms is 14.63 ± 3.09 liters. Lind with the result of Nigusu and Yoseph (2014) who found 14.1 liters/day/cow in urban and secondary town dairy production systems in Adama milk shed and with the result of FUADC (2023) average daily milk report were 14.64 liters/day/cow in Addis Ababa sub city. The current result contrast with Kiros *et al.* (2018)Crossbred cows in the towns of Bishoftu and Akaki were estimated to have daily milk yields (DMY) of 11.6 and 10.8 liters, respectively, with Jalel et al.(2020)) The milk shed in Adama states that 11.3 liters and with Alemu (2019) Crossbred cows in Hawassa have an average daily milk yield (ADMY) of 10.32 liters.

The t-test value for the difference in Mean daily milk yield between the two farm scales is 1.475, with a corresponding p-value of 0.142, which is higher than the significance level of 0.05. This indicates that the difference in daily milk yield between farms were not

statistically significant. The result shows that farm scale may not be a critical factor in achieving optimal milk production.

The mean lactation length for dairy cows in Table 16 indicates that cows from MS and SS farms have a mean lactation length of 8.05 ± 1.23 months and 8.1 ± 1.24 months, respectively, which is shorter than the durations seen in previous studies. Crossbred dairy cows in Debre-Birhan and Sebeta lactated for 9.7 and 10 months, respectively. Similarly, lactation durations of 10.53 and 12.0 months have been reported for the cities of Shambu and Kombolcha in the Oromia region, while cows in Melkasa and Welenchiti had lactation periods of 10.8 and 11.4 months, respectively as reported by Dinkissa and Guye (2022), Dinkissa and Girgo (2022) reported that lactation lasted 8.7 months in Debre Markos and more than 9.17 months in Gondar town by Alemu (2019), In Bahir Dar Zuria, cows spent eleven months lactating (Getachew and Tadele), According to Genzebu et al.(2016), in Bishoftu, lactation lasted 9.22 months, while in Akaki town, it lasted 9.36 months and In the North Shoa zone, native dairy cows breastfed for 9.13 months, while crossbred cows breastfed for 11.13 months Hatew et al. (2023). The current result shows farmers adopt early detection of heat and on time insemination.

The t-test value for the difference in lactation length between the two farms is 0.616, with a p-value of 0.796, indicating that the difference is not statistically significant. The similar lactation length between MS and SS farms can help inform farm management decisions and planning, suggesting that the scale may not be a significant factor in achieving optimal lactation performance.

Table 16 Milk Yield

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Milk yield Measured on the farm.	Individual cow milk recording	44	41.1	25	33.3
	Bulk tank measurement	63	58.9	50	66.7
Seasonal variations in milk yield.	Yes	107	100.0	75	100.0
Daily milk yield(mean ±SD)		13.93 ± 3.16		14.63 ± 3.09	
t-test				1.475	
p-value				0.142	
Lactation length in month (mean ±SD)		8.05± 1.23		8.1± 1.24	
t-test				0.616	
p-value				0.796	

4.13 MILK COMPOSITION

A study in Table (17) shows that only 0.9% of medium-scale farms tested milk composition, with 99.1% not. This lack of testing indicates a potential gap in monitoring milk quality and nutritional content. The study also suggests that current milk prices in the area are often based on milk volume, which may incentivize farmers to focus more on increasing milk yield. The findings suggest the need for increased adoption of milk composition testing at the farm level and through regulatory bodies or industry initiatives. This could help farmers make informed decisions about herd management, feed formulation, and product differentiation.

Table 17 Milk Composition:

Variables		Medium scale (n=107)		Small scale (n=75)	
		Frequency	%	Frequency	%
Did you test milk Composition?	Yes	1	0.9	0	0
	No	106	99.1	75	100.0
How is milk composition tested?	Didn't test milk at all	106	99.1	75	100.0
	On-farm testing kits	1	0.9	0	0
Are there any variations in milk composition among different cows	Yes	1	1.9	1	1.3
	No idea	106	99.1	74	98.7
Are there any variations in milk composition among different lactation stages?	Yes	1	1.9	1	1.3
	No idea	106	99.1	74	98.7

Table 18 Milk composition Laboratory result

Variables	Medium scale (n=18)	Small scale (n=12)		
	Mean ±Std.	Mean± Std.	t-value	p-value
Fat	2.53±1.54	4.43±1.408	3.411	0.002
Protein	3.09±0.165	3.07±0.306	-0.178	0.860
Solid Not Fat	8.45±0.424	8.44±0.822	-0.016	0.987
Lactose	4.64±0.232	4.64±0.454	-0.044	0.965
Total Solid	10.85±1.533	12.87±1.568	3.497	0.002
Ash	0.69±0.036	0.68±**0**.071	-0.078	0.938
Density	29.88±2.595	28.19±3.413	-1.548	0.133
Freezing Point	-0.53±0.025	-0.53±0.055	-0.264	0.793
Temperature	22.93±2.102	22.98±1.701	0.067	0.947
PH	7.02±1.277	6.69±0.160	-0.886	0.293

Based in the table (18) data for the variables in MS (n=18) and SS (n=12)

The average fat content in MS farms (2.53% ± 1.54%) is below the acceptable level of 3.34% according to the Ethiopian Standard (CES 2021). On the other hand, the average fat content in SS farms (4.43% ± 1.408%) exceeds the CES 2021 standard. There is a statistically significant difference in fat content between MS and SS farms (p-value = 0.002 < 0.05), which aligns with the findings of Samuel Abose (2020), the fat contents of milk collected from smallholder micro-enterprises, smallholder farmers, and selling points of shops were 2.81±0.13, 3.47±0.46, and 1.37±0.25, respectively. The overall mean value of milk fat (2.56%) in Sebeta town was lower than the 3.50% indicated in the Quality Standard Authority of Ethiopian (ES, 2009), similar to the MS fat in the current study and contrast with the result of Duguma (2022) mean fat of 3.97 ± 0.01 , which is higher than MS and lower than SS farms. The findings of Asefa and Teshome, (2019) regarding the

milk shade around Addis Ababa showed that Wolmera had the highest fat content at 4.87%, followed by the Sebeta site at 4.8%. This report is nearly consistent with SS farms in the current study. In contrast, the lowest fat content of 2.42% was observed in Selale, which is in line with the current finding of MS farms.

The mean protein content in MS farms (3.09% ± 0.165%) and SS farms (3.07% ± 0.306%) are both within the acceptable level of 3.07% as per CES 2021. The difference in protein content between MS and SS farms is not statistically significant (p-value = 0.860 > 0.05). The current result were higher than the protein 2.61±0.64 reported by Bekuma et al.(2023) in Wachale District, North Shewa and closest result reported by Duguma (2022) in selected towns of Jimma Zone, Oromia Regional State, Ethiopia which is 3.28 ± 0.03.

The mean SNF content in MS farms (8.45% ± 0.424%) and SS farms (8.44% ± 0.822%) are both within the acceptable range of 8.38% as per CES 2021. The higher standard deviation in the small-scale data suggests more variability in SNF content. The difference in SNF content between MS and SS farms is not statistically significant (p-value = 0.987 > 0.05). agreed with the result reported by Duguma (2022), the mean SNF of cross bred cows was 8.55 ± 0.02 in selected towns of Jimma Zone, Oromia Regional State, Ethiopia, and higher than Bekuma *et al.* (2023) result mean mean SNF was 7.24±.0.16

The mean lactose content in MS farms (4.64% ± 0.232%) and SS farms (4.64% ± 0.454%) are similar within an acceptable range. The standard deviation in the small-scale data suggests slightly more variability in lactose content. The difference in lactose content between MS and SS farms is not statistically significant (p-value = 0.965 > 0.05). similar result with L Abagero (2016), the overall mean ± SD lactose content reported were 4.69±0.83 which is no significant difference (P>0.05) was observed in lactose content between Peri-urban and rural production system.

The average TS content in SS farms (12.87% ± 1.568%) is higher than in medium-scale (MS) farms (10.85% ± 1.533%), suggesting a higher concentration of solids in the milk from small-scale farms. Both scales have average TS values within an acceptable range. The difference in TS content between MS and SS farms is statistically significant (p-value = 0.002 < 0.05). In contrast to the findings of Bekuma *et al*. (2023) results of 11.20% ± 0.33,which shows smaller TS results of MS farms and larger TS results of SS farms.

Similar results were observed in Sebeta City smallholder farms by Samuel Abose (2020), with a mean TS content of 12.53% of SS farms and 10.51% of MS farms in current study.

The mean ash content in MS farms (0.69% ± 0.036%) and SS farms (0.68% ± 0.071%) are similar and within an acceptable range. The standard deviation in the SS data suggests slightly more variability in ash content. The difference in ash content between MS and SS farms is not statistically significant (p-value = 0.938 > 0.05). According to Asefa and Teshome (2019) A significantly higher ash content of 0.74% was observed in milk samples from Debrezeit, and a lower ash content of 0.69% was observed in Sebeta, the current result lined with the sebetas result.

The mean density in MS farms (29.88 g/cm³ ± 2.595) and SS farms (28.19 g/cm³ ± 3.413) are within the acceptable range of 1.026 g/mL - 1.032 g/mL at 20°C as per CES 2021. The small-scale data has a higher standard deviation, indicating more variability in density. The difference in density between MS and SS farms is not statistically significant (p-value = 0.133 > 0.05). consistent with the study by Mekasha *et al.* (2021), found the mean milk density to be 1.027 ± 0.002 g/mL in small-scale dairy farms in the Addis Ababa area and the study by Tesfay (2020), reported the mean milk density were 1.030±0.001 g/mL in physico-chemical properties of cow milk in the Dire Dawa town eastern Ethiopia, also aligning with the results of this study.

The mean freezing point in MS farms (-0.53°C ± 0.025) and SS farms (-0.53°C ± 0.055) are within the acceptable range of -0.525°C to -0.550°C as per CES 2021. The standard deviation in the small-scale data suggests slightly more variability in freezing point values. The difference in the freezing point between MS and SS farms is not statistically significant (p-value = 0.793 > 0.05). Mekasha *et al*. (2021) found the mean milk freezing point to be -0.535 ± 0.004°C in small-scale dairy farms in the Addis Ababa area, which is consistent with the findings in this study. Tesfay (2020) reported the mean milk freezing point to be -0.536 ± 0.003°C in physico- chemical properties of cow milk in the Dire Dawa area, also aligning with the results of this study.

The mean temperature in MS farms (22.93°C ± 2.102) and SS farms (22.98°C ± 1.701) are within a reasonable range. The standard deviation in the small-scale data suggests slightly less variability in temperature. The difference in temperature between MS and SS farms is not statistically significant (p-value = 0.947 > 0.05). the current result is higher than that of

Mekasha et al. (2021), who found the mean milk temperature to be 20.5 ± 1.5°C in small-scale dairy farms in the Addis Ababa area, and also with the study result of Tesfay (2020) reported the mean milk temperature to be 20.8 ± 1.2°C in smallholder dairy farms in the Dire Dawa area,

The mean pH in MS farms (7.02 ± 1.277) is outside the acceptable range of 6.6-6.8 as per CES 2021, while the mean pH in SS farms (6.69 ± 0.160) is within the acceptable range. The small-scale data has a lower standard deviation, indicating less variability in pH. The difference in pH between MS and SS farms is not statistically significant (p-value = 0.293 > 0.05). Contradict with the result of Asefa and Teshome (2019), pH has a significant difference between each study site. Significantly lower pH of 6.02 and 6.17 was observed in Debrezeit and Sebeta milk shade. Milk from Wolmera and Selale were pH of cloth to normal pH range, milk collected from the four sites was pH of lower than Ethiopian standards of 6.60 to 6.80.

The data presented in Table 18 indicates that small-scale farms generally have higher fat, total solids (TS), and pH values compared to medium-scale farms. The differences in fat and TS levels are statistically significant. These findings suggest that both management practices (such as feeding, milking techniques, and health management) and genetic factors (breed selection and genetic diversity) play crucial roles in influencing the fat and solid-not-fat content of milk in farms. Although farmers may not be aware of their cow's blood levels, phenotypically observed levels appear to be higher in medium-scale farms due to exotic blood It’s important to note that increasing exotic blood levels may decrease fat content and solid-not-fat levels, which could explain why small-scale farms have higher fat and solid-not-fat content than medium-scale farms. Implementing best practices in management and focusing on genetic improvements can help enhance milk quality on both small and medium-scale farms. However other milk quality parameters are similar between the two farm scales, with no statistically significant differences. However, L Abagero (2016) reported a significant difference ($P < 0.05$) in the total solids (TS), solid-not-fat (SNF), and ash content of milk samples collected from peri-urban and rural kebeles of Agarfa, Oromia regional state.

5. CONCLUSION

The assessment of farm management strategies on milk yield and composition in small and medium-scale dairy farms in Addis Ababa, Ethiopia, reveals several key insights. Both medium-scale (MS) and small-scale (SS) dairy farms utilize conventional housing but require enhancements in design, maintenance, breeding management, record-keeping, waste management, and animal health practices. To boost productivity and sustainability, it is essential to focus on effective waste management systems, access to affordable and high-quality animal feed, and robust animal health programs. Interestingly MS and SS farms exhibited similar mean lactation lengths and daily milk yields, which were shorter than previously documented durations. The lack of significant differences between the two farm scales in terms of lactation length and daily milk yield implies that factors such as breed, age, nutrition, and management practices play a more crucial role in influencing these outcomes than the scale of the operation itself. While SS farms demonstrated higher fat content and total solids in milk compared to MS farms, farmers may not be aware of their cow's blood levels, phenotypically observed levels appear to be higher in medium-scale farms due to exotic blood It's important to note that increasing exotic blood levels may decrease fat content and solid-not-fat levels, which could explain why small-scale farms have higher fat and solid-not-fat content than medium-scale farms. the differences in other quality parameters were not statistically significant. This suggests that SS farms may produce milk with richer composition; this may show that both management practices (such as feeding, milking techniques, and health management) and genetic factors (breed selection and genetic diversity) play crucial roles in influencing the fat and solid-not-fat content of milk in small-scale farms. Implementing best practices in management and focusing on genetic improvements can help enhance milk quality in these farms. The dairy operations (SS vs. MS) did not significantly impact milk yield and most milk quality parameters, suggesting that management practices and other factors are more important determinants of dairy farm productivity and milk composition in the Addis Ababa region of Ethiopia.

6. RECOMMENDATION

- Government and non-governmental organization (NGO) support is crucial for sustainable dairy cattle management training on feed formulation, proper feeding practices, herd health, breeding management, and entrepreneurial skills. Implementing best practices in dairy management can increase milk yield and quality.
- On the dairy farm, managing waste is a growing challenge. Composting, installing drainage systems, and converting manure into biogas should be prioritized, especially for medium-scale farms.
- Regular dairy cattle milk composition tests can provide valuable insights to enhance dairy productivity and ensure product quality.

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8. APPENDIX

Questioner

Dear respondent, I am a graduate student in the department of animal production technology from federal TVET institute Currently, I am undertaking a research entitled 'Assessment of on farm management strategies on milk yield and milk composition of small and medium scale dairy farms in Addis Ababa, Ethiopia" You are one of the respondents selected to participate on this study. Please assist me in giving correct and complete information to present a representative finding on the current status of your farm. All information will be used for academic purposes only. Thank you in advance for your kind cooperation and dedicating your time.

I. Respondents Characteristics/General Information

1.1. Where is your sub-city and woreda located?

A. Akaki kality, woreda 7. ☐ 10. ☐

B.Yeka, woreda 9. ☐ 11. ☐

C. Bole woreda 1. ☐ 12. ☐

1.2. Sex? 1. Male ☐ 2, Female ☐

1.3. Marital status? 1. Married ☐ 2. Single ☐

3. Widow ☐ 4. Divorced ☐

1.4. Age 1. 18-28 ☐ 2. 29-39 ☐

3. 40-50 ☐ 4. Above 50 ☐

1.5. What is your educational level? 1. Illiterate ☐ 2. Read and Write ☐

3. Elementary ☐ 4. High school ☐ 5. Diploma ☐

6. Degree and above ☐

II. General Farm Information:

2.1. Which type of dairy farm owner/s are you?

1, Individual ☐ 2, Cooperatives ☐

2.2. How many years experienced 1, Less than 2 year ☐ 2, 2to 3 years ☐

3, 3 to 5 years ☐ 4, More than 5 year ☐

2.3. How many dairy cattle are present on the farm?

1. Less than or equal to 5 ☐ 2. More than 5 ☐

2.4. What is the breed or variety of the dairy cattle reared in your farm?

1. Local ☐ 2.mixed (local and cross within the farm) ☐

3. Cross breed ☐ 4. Other------

2.5. If you know the blood level of your dairy cattle, what percentages of them have exotic blood levels?

1, Don't now 2, Less than 25% ☐ 3, 25 – 50% ☐

4, 50-75% ☐ 5, 75 - 87 % ☐ 6, more than 87 % ☐

III. Management Related questions

No	**Description**		Yes	No
3.1	**Housing management**			
3.1.1	Types of House used	Did you use convectional housing (Tie barn) in your farm?		
3.1.2	Barn Design	Was the barn designed to provide adequate space, ventilation, and lighting for the cows?		
3.1.3	Ventilation	Did you Provide proper airflow and ventilation to maintain air quality and prevent heat stress?		
3.1.4	Stall Management	Did you Ensure individual cow stalls are clean, comfortable, and properly sized?		

3.1.5	Lighting	Did you Provide appropriate lighting conditions to promote cow activity and comfort.			
3.1.6	Maintenance and Repairs	Did you Regularly inspecting and maintaining the barn structure, equipment, and facilities?			
3.2.	**Dairy cattle feeding managements**			Yes	No
3.2.1	Feeding Frequency and Timing	Have you ensured that your farm has a consistent feeding schedule and access to fresh feed?			
3.2.2	Feed Delivery and Bunk Management	Did you minimize feed waste and properly provide the cows with their grain?			
3.2.3	Forage Management	Did you oversee the growing, gathering, and storing of fodder crops? If it exist?			
3.2.4	Concentrate Feeding	Did you add concentrates to your forage diet to meet your needs for protein and energy?			
3.2.5	Ration Formulation	Have you formulate ration for your dairy cattle that satisfy the needs of the cows?			
3.2.6	Feed Efficiency Monitoring	Did you monitor feed efficiency, cow performance, milk production, and feed intake?			
3.2.7	Feed Storage and Quality	Did you store feedstuffs correctly to preserve their nutritional value?			
3.2.8	Use the by-products as animal feed	Have you feed treated brewery by-products to animal feed to reduce expenses?			
3.3	**Dairy cattle watering management**				
3.3.1	Water accessibility	farms always have to clean, fresh water	unrestricted access		
			Restricted access		
3.3.2	Automatic Waterers	Have you Installed automatic waterers that provide a constant supply of clean water can ensure that cows have access to water at all times?		Yes	No
3.3.3	Clean Troughs or Waterers	Did you Provide clean and well-maintained troughs or waterers that are free from contaminants and debris?			

3.3.4	Strategic Placement	Did you Placed water sources in easily accessible areas, minimizing long distances or obstacles that may prevent cows from accessing water?		
3.3.5	Backup Water Sources	Did you have backup water sources or contingency plans in place in case of water system failures or emergencies?		
3.4	**Dairy health care management**			
3.4.1	Routine Health Checks	Do you monitor individual cows or the entire herd for signs of illness, injury, or disease?		
3.4.2	Vaccination Programs	Have you implemented any vaccination programs to protect your cows from infectious diseases?		
3.4.3	Hoof Care	Did you regularly inspect and maintain your dairy cows' hooves to prevent lameness and other related issues?		
3.4.4	Reproductive Management	Did you monitor and manage the cows' reproductive health to ensure high breeding success rates?		
3.4.5	Mastitis Prevention and Treatment	Have you established any procedures to prevent and handle udder irritation or mastitis in your farm?		
3.4.6	Parasite Control	Have you implemented measures to prevent and treat both internal and external parasites?		
3.4.7	Collaboration with Veterinarians	Have you worked together with veterinarians to create and execute efficient health management programs?		
3.5.	**Breeding management**		**Yes**	**No**
3.5.1	Mating system	Did your farm use artificial insemination (AI) techniques?		
		Did your farm use Natural matting (NM) techniques?		
3.5.2	Artificial Insemination (AI)	If you Used AI techniques to breed cows, Did you choose genetically superior sires and allowing for controlled genetic improvement?		
3.5.3	Natural matting (using bulls)	If you Used (NM), Did you Conduct examinations of both bulls and cows to ensure their ability to breed successfully?		
3.5.4	Heat Detection	Did you Implement methods to accurately identify cows in heat for timely insemination?		

3.5.5	Estrus Synchronizatio n	Did you Employ synchronization protocols to optimize the timing of heat and insemination within the herd?		
3.5.6	Pregnancy Diagnosis	Did you diagnose pregnancy status in cows to identify open cows and manage breeding outcomes?		
3.5.7	Breeding Program Evaluation	Did you evaluate and adjusting the breeding program based on performance outcomes and genetic progress?		
3.6.		**Milking management activities**	Yes	No
3.6.1	Pre-Milking Preparation	Have you implemented cleaning and sanitizing the udder and teats before milking to ensure milk yield and reduce the risk of mastitis?		
3.6.2	Milking Routine	Did you maintain a consistent milking routine that included gentle and efficient milking?		
3.6.3	Milking Equipment Maintenance	Did you Regularly inspecting, cleaning, and maintaining milking equipment to ensure proper functioning and prevent contamination?		
3.6.4	Post-Milking Teat Dipping	Did you Apply a suitable teat dip or post-milking treatment to protect the teat end from bacteria and promote udder health?		
3.6.5	Milking Parlor Hygiene	Was your milking parlor clean and hygienic?		
		Were surfaces and equipment regularly disinfected?		
3.6.6	Milking Time and Frequency	Did you establish a consistent milking schedule, typically twice a day, for most dairy operations?		
3.7.	**Dairy cattle west control management**		Yes	No
3.7.1	Manure Storage and Handling	Did you Implement appropriate storage systems and handling practices?		
3.7.2	Odor Control	Did you take measures to reduce odor from manure storage, such as covering it or using odor-reducing additives?		
3.7.3	Composting	Have you used composting techniques to convert manure and organic waste into valuable soil amendment?		
3.7.4	Biogas plantation	Is there a way to save energy by using animal dung to electric service?		

3.7.4	Environmental Compliance	Did you Stay up to date with local, regional, and national regulations related to waste management and ensuring compliance with relevant standards?		
3.8.		**Dairy cattle record keeping management**	**Yes**	**No**
3.8.1	Her Health Records	Did you Maintain detailed records of cow health, including vaccinations, treatments, and health events, to monitor individual and herd health status?		
3.8.2	Milk Production Records	Did you Record daily milk production data for each cow, allowing for monitoring of individual cow performance and assessing overall herd productivity?		
3.8.3	Reproduction Records	Did you Tracking breeding dates, heat detection, pregnancy diagnosis results, and calving information?		
3.8.4	Feed and Nutrition Records	Did you Document feed composition, feeding practices, and nutritional information?		
3.8.5	Financial Records	Did you Keep track of expenses, income, and financial transactions to assess profitability, manage costs, and aid in financial planning?		
3.8.6	Inventory Records	Did you Maintain records of herd inventory, including the number of animals, births, deaths, and culling, to track herd size and make management decisions?		

IV. Milk Yield Assessment:

4.1. If your answer for question 3.8.2 yes. How milk yield measured on the farm?

1. Individual cow milk recording ☐ 2. Bulk tank measurement ☐ 3. Other ☐

4.2. What is the average daily milk yield per cow?

4.3. Are there any variations in milk yield throughout different lactation stages?

1. Yes ☐ 2. No ☐

4.4. Are there any seasonal variations in milk yield? 1. Yes ☐ 2. No ☐

4.5. What is the lactation length of your dairy cows in month?

V. Milk Composition Assessments:

5.1. Do you test milk composition in your farm? 1, yes ☐ 2, No ☐

5.2. If your answer for question 5.1 yes. How is milk composition tested?

1. Laboratory analysis ☐ 2.On-farm testing kits ☐ 3. Any other……

5.3. Are there any variations in milk composition among different cows?

1. Yes ☐ 2. No ☐ 3.No idea ☐

5.4. Are there any variations in milk composition among different lactation stages?

1. Yes ☐ 2. No ☐ 3.No idea ☐

5.5. Are there any changes in milk yield and composition observed after implementing certain management practices? 1. Yes ☐ 2. No ☐

VI. Open Question

6.1. What are the challenges faced by the farms in implementing these on-farm management strategies, and how do they perceive the impact of these strategies on milk yield and composition? ----------

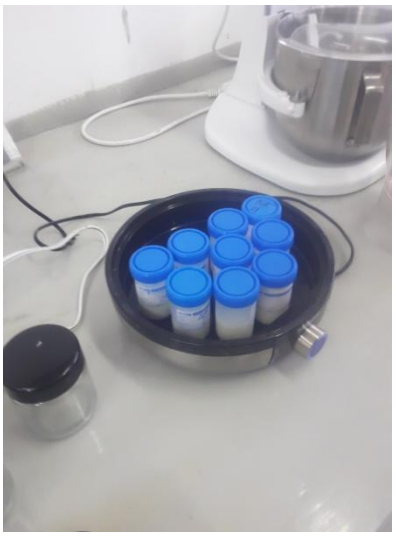
6.2. Describe the type of feed that enables your farm produce more milk? ----------

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6.3. Which type of exotic blood levels are used in your farm? ----------

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6.4. From question 6.3 why you prefer those type of blood level? ----------




Results
F=02.22 S=08.52
D=30.31 P=03.12
L=04.68 W=00.0
LACTOSCAN
ULTRASONIC MILKANALYZER
ENTER


Page2 Resu
T=20.1
FP=-0.531
S=00.69
LACTOSCAN
ULTRASONIC MILKANALYZER
ENTER

